**Geosciences Research, Resource Development, Monitoring and Evaluation through Nanoscanner/Drone Technology**

Over the past decade or more, the development and application of nanoscanner (small-scale sensor, or nanosensor) and drone technology for medical and health, energy and water management, physical infrastructure and antiquities, military surveillance, warfare, defense, and security purposes has mushroomed. These technologies are rapidly expanding to agriculture and food quality and safety and security, environmental, and natural resource research, development, and management. Their use is changing the way traditional practices are moving forward to increase understanding, productivity, and value on a new and higher scale. They have gone way beyond aerial photography and geophysical technologies for resources management.

IBM's Chief Innovation Officer and Vice President, Bernard Meyerson, summarized the top 10 emerging technologies of 2015 in a Scientific American note, based on the World Economic Forum's Meta-Council on Emerging Technologies. He included autonomous drones ("flying robots") as "better able to process and respond to visual cues, much more powerful and intelligent cameras and smartphones, and data-crunching on a scale that may help unlock the secrets of financial markets or climate forecasting. Computers will be able to anticipate and learn, rather than merely respond in preprogrammed ways."

For geosciences, these applications include, for example, study and monitoring of landforms and features, glaciers and ice sheets and ice bergs, greenhouse gases, avalanches and landslides, volcanic eruptions, urban heat islands, building energy, floods and droughts, drainage, sea level changes, advancing and retreating coasts, weather patterns, mechanical weathering and erosion, geothermal resources, and mineral deposits and mining. The basic principles are as follows:

1. Collection of accurate, real-time data, such as high-fidelity sensing (scouting or monitoring) and precise positioning (location) through high-resolution, on-demand visual and electro-optical/ thermal infrared mapping to obtain a detailed view from nanoscanners feeding back information to drones (unmanned aircraft), manned aircraft, satellites, or other stationary or mobile air or land centers
2. Centralization of collected data (often called "big data")
3. Massaging collected data in a form to identify spatial and temporal trends, anomalies, inconsistencies, and comparison to established specifications, standards, and deviations
4. Decision-making to identify appropriate action alternatives and recommend actions
5. Implementation of appropriate actions
6. Reassessment through monitoring and evaluation

Unfortunately, much of the best technology is confidential, proprietary, and security sensitive, but entrepreneurs are rapidly licensing and developing commercially available technologies.

**References**

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